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MITIGATING HUMAN ELEPHANT CONFLICT: A CHILLY (*Capsicum annum*) FENCE EXPERIMENT FROM HOSUR FOREST DIVISION, SOUTHERN INDIA.

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Crop damage by elephants has been a major challenge for elephant conservation in Asia and Africa. Increasing incidence of crop damage has lead to innovation of different methods to protect crops. Several mitigating measures have been tested for their efficacy in Asia. Elephant proof trench, rubble wall and solar fences are three major approaches. Most of these methods are expensive and effective only in the short term. Hence we needed a method that was economically viable, locally implementable and capable of widespread application. Chilly based repellents using various delivery systems to control elephant depredation of agricultural crops have been in vogue over the past decades in Africa. We therefore tested the efficacy of 'chilly fence' at Hosur Forest Division in the state of Tamil Nadu, Southern India representing a low rainfall area (<500mm).

We tested the efficacy of the repellent using a mixture of chilly and tobacco (*Nicotiana tabacum*) powder mixed with waste engine oil (1:1:10 ratio) which was applied to cotton ropes and these were encircled the agricultural fields of 5.5 km perimeter as barrier. The repellent was applied twice/week. However, during rainy days the frequency of application increased to thrice/week. The major crops cultivated in the experimental village were ragi (*Eleusine coracana*) horse gram (*Dolichos biflorus*), and paddy (*Oryza sativum*), which are highly preferred by elephants. Observations of elephant approaches to the crop field were monitored for a period of 44 days during reproductive phase of main cultivation season in late 2006. Frequency of elephant approach details such as distance at which elephants were repelled by the fence, observation on elephant behavior towards the fence and deterrent methods if used by farmers were observed.

The chilly fence proved to be effective in Hosur Forest Division as it repelled 79% of 34 elephant approaches. The fence was more effective in deterring female led herds (94.4%) compared to solitary individuals (62.5%). 2X2 Fisher exact P=0.035 indicates repelled and breaches were dependent on the sex of the animal. Out of seven fence breaches, 57% happened during rainy days indicating a negative influence of rainfall on the chilly fence efficacy. Spearman's rank order correlation coefficient =0.169, P=0.27 indicates no correlation between elephant approach and rainfall. Frequency of elephant encounter in a given day ranged from 1-5. The distance from which elephants were repelled varied from 5-23 meters. Several incidences of female herds trumpeting while retreating back from fence were observed. Female herd walked along the fence and entered the crop field through a narrow gap for vehicle entry were recorded, subsequently gap were fenced during night. Solitary male stepped over the fence pole and entered the crop field were some of the interesting elephant behaviour observed during the study period.

These results suggest that chilly fences have the potential to reduce crop damage by elephants in the low rainfall area but have to be used judiciously to obtain optimal results. Establishing the fence during the peak raiding period reduces the opportunities for elephants to habituate themselves to the chilly fence. This experiment needs to be tested with various ratios of repellents at different levels of conflicts.

Introduction

Crop damage by elephants has been a major challenge for elephant conservation in Asia and Africa. Escalating incidence of crop damage in the recent decades leads to innovation of different mitigating measure to protect the crops from elephants. Several mitigative measures have been tested for their efficacy in Asia under different conditions. But most of which are yielded unsatisfactory results or expensive, effective only in short term. The traditional methods for deterring crop raiding elephants, such as fire and sound making devices have generally failed except when the animals are closer to the field (Bell and McShane-Caluzi 1984). Elephant proof trenches and Rubble walls are very expensive and not suitable for high rainfall and loose soil areas (Veeramani *et al.* 2004).

Electric fencing proved to be marginally effective (Sukumar 1985, 1986, Schultz 1986, 1988, Santiapillai and Jackson 1990, Banerjee 1994, Chandrasekaran 1994, Sheety 1994, Bist 1996) in some parts of the country, still its failed against the habitual crop raiders therefore electric fence needs to be backed with special protection (Thouless and Sakwa (1995 a, b) for long term solutions. Hence most of the methods are failed against the quick learners; arouse the urgency to find a method, which is low cost, reliable active elephant repellent for long-term solutions against crop raiding elephants. Studies in Africa report that the capsaicin chemical found in fruits of Capsicum *spp.*, which is the agent that makes the taste hot by stimulating nociceptors of the trigeminal system (Rasmussen 1994) alter the behavior of various animals (Hunt 1995, Andelt *et al.* 1992, Bullard 1985). Capsicum based repellents tested in Africa have shown promise as elephant repellents (Osborn and Rasmussen 1995, Osborn 1998, Osborn *et al.* 2002). We experimented therefore with the relatively cost-effective chilly grease fence version of the repellent system in Hosur forest division in Southern India. The present study was aimed to evaluate the efficacy of chilly based repellent in preventing elephants' entry into crop field and suggest recommendations for the effective use this technique in other areas.

Study Area

Gullatti Village of Hosur forest division (Fig: 1) lying in the Krishnagiri District of Tamil Nadu forms a part of the Eastern Ghats. It has contiguity with Bannerghatta National Park in the north, Kanakapura Reserve Forest in the west, and Dharmapuri Forest Division in the east, and Cauvery Wildlife Sanctuary in the south. The area is spread along the receding slopes of the Mysore plateau. The Melagiris is a loose chain of hills that runs roughly in the north – south direction from Denkanikotta to the Cauvery plains. On the Western sides there are small outcrops of rocks. The altitude of the area ranges from 400 to 1000 meters above the mean sea level (MSL) and then declines gradually towards the south. The area is drained by two rivers namely Doddahalla and Chinnar. Doddahalla, which runs through the heart of Hosur division and the Chinnar, which originates from Thally and runs along the eastern foothills of the Melagiris, both drain into river Cauvery. The reserve forest consists of mixed dry deciduous, dry deciduous, secondary dry deciduous, riverine, and dry thorn forest (Ramesh Kumar, 1994). The area receives rainfall from both southwest and northeast monsoons. The temperature ranges from 10°C to 35°C.

Methods

A mixture of chilly and tobacco (*Nicotiana tabacum*) powder mixed with waste engine oil (1:1:10 ratio) which was applied to cotton ropes and these were encircled the agricultural fields of 5.5 km perimeter as barrier. The fence was established and maintained by the people of Gullati village. The repellent was applied twice/week. However, during rainy days the frequency of application increased to thrice/week. The major crops cultivated in the experimental village were ragi (*Eleusine coracana*) horse gram (*Dolichos biflorus*), and paddy (*Oryza sativum*), which are highly preferred by elephants. Observations of elephant approaches to the crop field were monitored for a period of 44 days (from November 9th to December 22nd) during reproductive phase of main cultivation season in late 2006. Details such as frequency of elephant approach, distance at which elephants were repelled by the fence, elephant behavior towards the fence and deterrent methods if used by farmers were observed.

Results

The chilly fence proved to be effective in Gullatti village of Hosur Forest Division as it repelled 79% of 34 elephant approaches. The fence was more effective in deterring female led herds (94.4%) compared to solitary individuals (62.5%) (Table1). To test whether repelled and breaches were dependent or independent of sex ***2X2 fisher test*** of independence was performed. The analysis ***(P = 0.035)*** showed significant differences in number of repels and breaches by solitary

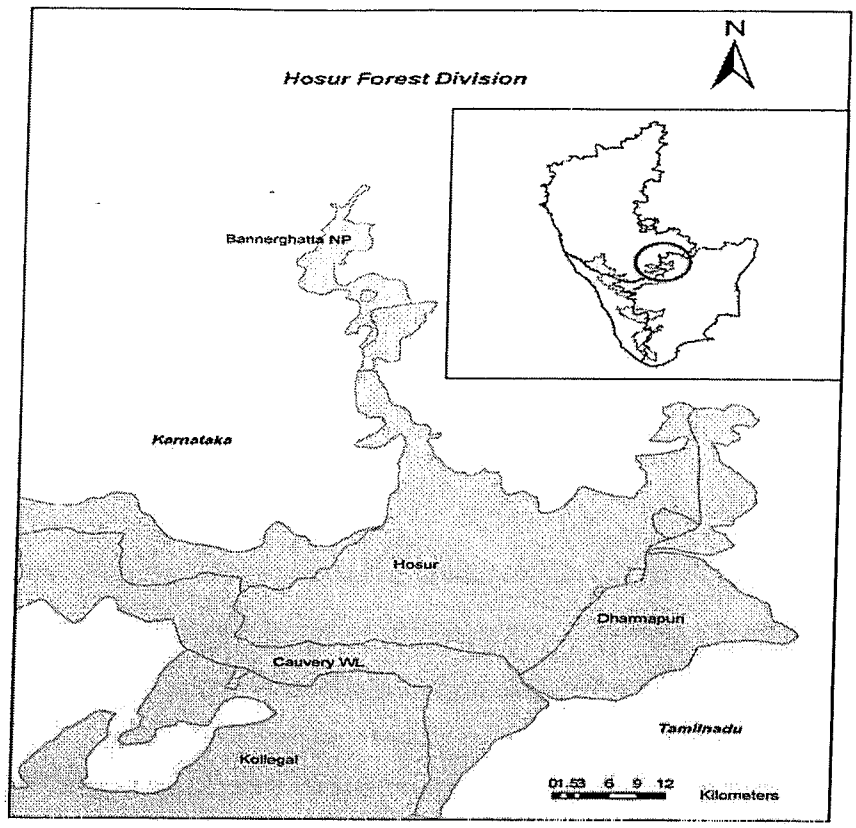

Fig: 1 Map showing the Hosur forest divison

Table: 1. Effectiveness of chilly fence against solitary and female led herds

Group type	Approached	Repelled	%	Breaches	%
Herd	18	17	94.4	1	5.6
Solitary male	16	10	62.5	6	37.5
Total	34	27	79.4	7	20.6

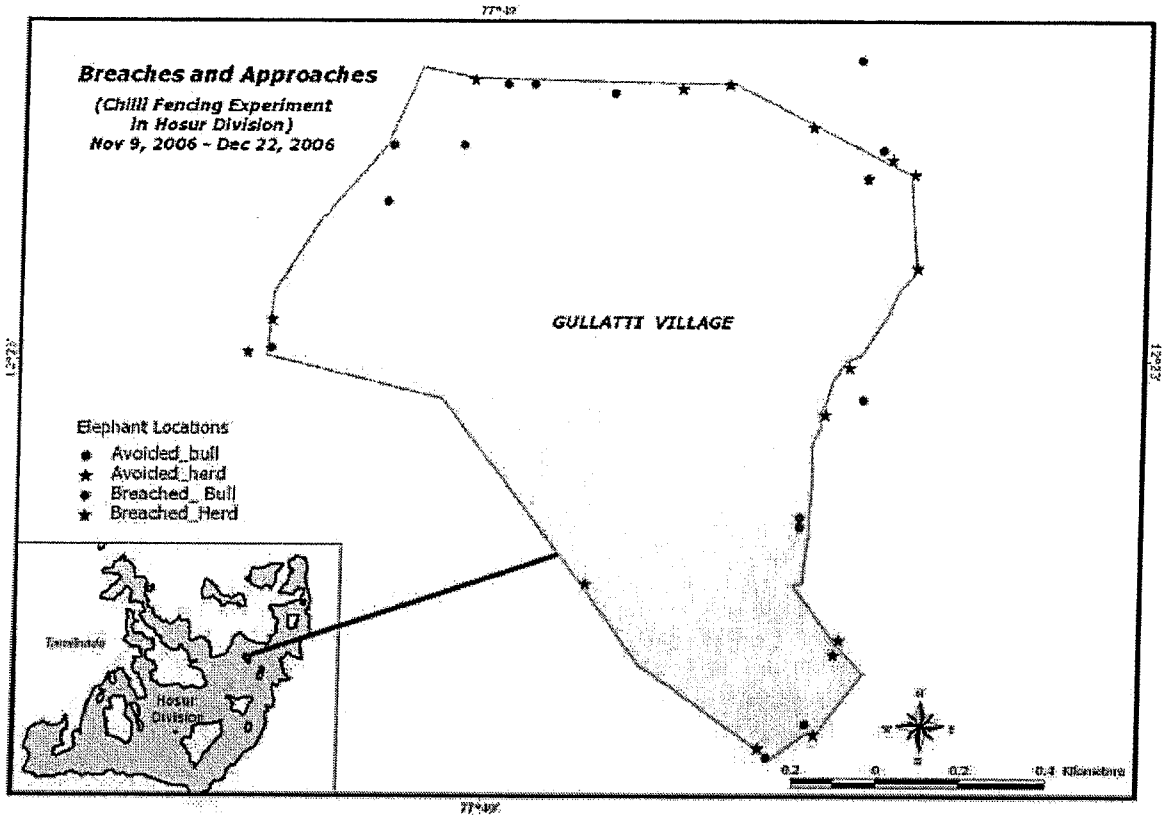

Fig: 2 Chilly fence repelled and breaching locations in the Gullatti village

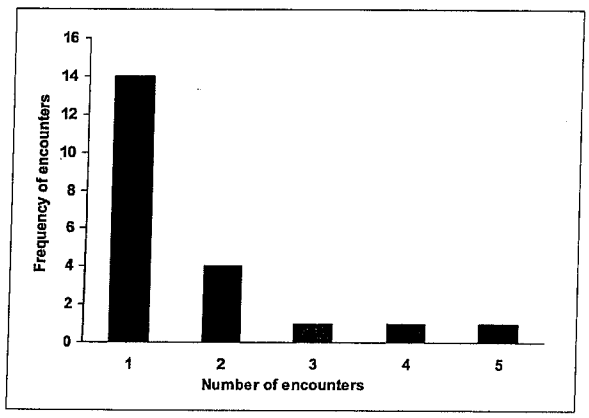

Fig: 3 Number of encounters by elephant in a given day

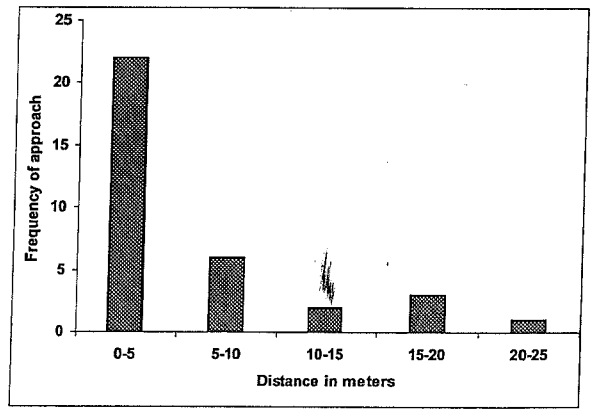

Fig: 4 Distance in which elephant approaches the fence

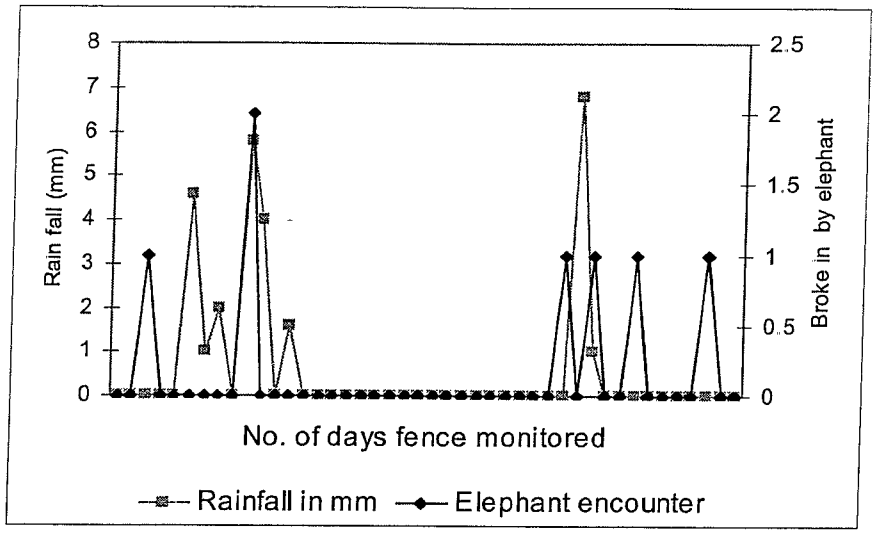

Fig: 5 Number of elephant encounter during rainy days

Table: 2 Crop damage compensation paid from 2004 – 2006 in the study area

Year	No.of.Cases	Compensation paid INR
2004	2	2000
2005	8	34200
2006	0	0

males and female led herds (Fig 2). This proves that repels and breaches were dependent on the sex of the animal. Frequency of elephant encounter in a given day was ranging from 1- 5 (Fig 3). The distance in which elephants repelled by the chilly fence varied from 5 – 23 meters (Fig 4). Seven out of the total breaches four happened during the rainy days indicating negative influence of rainfall on the fence efficacy (Fig 5). A statistical test (*Spearman's rank correlation)* was done to know the relationship between elephant approaches and rainfall. The Correlation coefficient value = 0.169, P=0.27 indicates that there is no correlation between elephant approaches and rainfall. Since we have experimented the chilly fence in low rainfall area, optimal sample size has not been obtained for rainfall in order to carry out any further detailed analysis. In order to test is there any relationship between lunar cycle and behavioral changes in elephant's crop raiding especially during new moon day's climate of the days had recorded. Since the experiment period was too short, influence of lunar cycle on crop raiding by elephants have not been captured. Compensation paid by Forest Department towards crop damage by elephants was collected from 2004 to 2006 to evaluate the differences in the intensity of crop damage both during and before the experimental period in Gullatti village (Table 2). The data showed a remarkable decline in the compensation amount paid during the experimental period indicating the effectiveness of the chilly fence in reducing the conflict.

Discussion

The fence was more effective in deterring female led herds compared to solitary males clearly indicates that female led

herds having calf and juveniles are very cautious to take decisions while solitary males take high risk to get a higher gain from the cultivated crops which have more nutritive value than wild food plants (Sukumar, 1988). Frequency of elephant encounter in a given day was ranging from 1- 5 showing the vulnerability of villages susceptible to crop damage and revealed the elephants have an acute sense of smell by elephant's, which probably would have attracted them to the crop site from a far away distance (Sukumar, 1989). The distance in which elephants repelled by the chilly fence varied from 5 – 23 meters. Frequency of elephant approaches was higher during flowering stage compared to vegetative or grain stage revealing that the nutritive value of Finger millet (*Eleusine coracana*) during flowering stage is higher than the wild plants including dicot browse (Sukumar, 1988). This is one of the major issues in triggering off the human elephant conflict. On the other side chilly fence proved to be an effective mitigation approach for solving the human elephant conflict, as it was able to deter the 80% approaches. Several incidences of trumpeting while approaching the fence and subsequently repel of the female herd on a given night and walking 5-10m away from the fence were the interesting observations representing effectiveness of chilly fence in keeping the elephants away from cultivated fields. Whereas on one of these nights a female herd was recorded to enter the crop fields through a gap in the fenced area (given for Vehicle entry to the village). The last recorded incidence shows the persistence and the high preference of the herd for the highly nutritive crops, thus utilizing every opportunity that they get to raid the crop fields. Crop damage compensation given by forest people from 2004 to 2006 clearly revealed the drastic reduction in the compensation amount indicating the efficacy of chilly fence to prevent crop damage by Asian elephants during the year of 2006 in the Gullatti village of Hosur forest division.

Recommendations

1. Establishing the fence during the peak raiding period reduces the opportunities for elephants to habituate themselves to the chilly fence.
2. This experiment needs to be tested with various ratios of repellents at different levels of conflicts.
3. Make farmers themselves responsible for implementing mitigation methods.

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